Elements of ECOSYSTEMS

Climate (*temperature, sunlight, wind, rain*), **topography** (*elevation, steepness, aspect*), and **soil** (*composition, depth, permafrost*) are the major **nonliving** elements that shape **ecosystems** for all **living things** and the **energy** exchange that links them.

Imagine a landscape devoid of living things. In a way, a lunar landscape, but with familiar landmarks. That is the canvas for painting an ecosystem – *the complex of living organisms and their physical environment*. These living and nonliving elements are *linked by a flow of energy and a cycling of materials*.

Section 1
ECOSYSTEM INSIGHTS

Sun's Energy
Alaska's Landscape
poster: *Nonliving+Living Things=Ecosystem*
Nonliving Elements
- Climate&Ecosystems
- Snowy Blanket
- Topography
- Soil

LivingThings–5Kingdoms
- Monerans
- Protists
- Fungi
- Plants
- Animals (Invertebrate)
- Animals (Vertebrate)

EnergyExchange

An ecosystem can be as small as a pond or as large as a continent. Prairie, rainforest, tundra, wetlands, coral reef – all are examples of ecosystems. All run on energy from the sun.

SUN'S ENERGY – ESSENTIAL FOR LIFE

Energy from the sun heats the surface of the earth to temperatures where life can exist. Both the amount of energy that reaches the surface and the duration of time the energy is present determine the **temperature**. The tilt of the earth's axis changes both of these factors on a daily and seasonal basis. This sets the stage for world **climate** differences, a major determinant of whether our local ecosystem is tundra, trees, or desert.

CLIMATE & ECOSYSTEMS

The sun's energy not only warms the environment to a degree where life can occur, but is a key ingredient in **photosynthesis** (food production from light energy, water, and carbon dioxide). This food production serves as the foundation for all life.

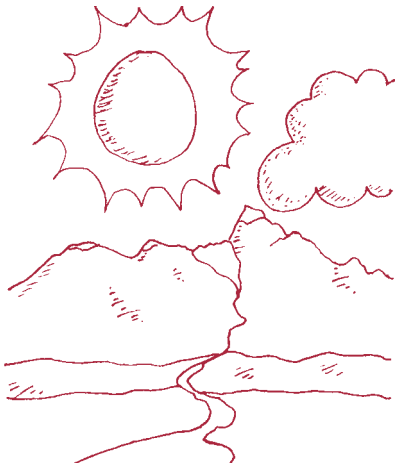
Photosynthesis Process. Plants and fungi absorb **photons** of sunlight from dawn to dusk. The energy contained in the photons is used by the cells to restructure chemical bonds and manufacture food sugars from mineral nutrients and water from the soil and carbon dioxide from the air.

Winter Dormancy. Plants cannot photosynthesize at temperatures below 19.4°F (-7°C). Other metabolic processes such as respiration also do not occur at temperatures much below this point. When cold temperatures and meager sunlight halt photosynthesis, growth stops and plants become dormant.

Summer Growth Surge. When temperature and sunlight allows, Alaska's plants grow more rapidly in order to complete their cycle in the short time available. Scientists studying white spruce in Alaska and Massachusetts found that the Alaska trees produced the same number of a certain cell, but in half as much time.

Comparative Study. Ironically, when scientists moved Alaskan trees to the Lower 48, they grew very slowly. In order to make them grow as fast as they do in Alaska, the length of daylight has to be increased to match Alaska summers.

ALASKA'S LANDSCAPE ICE AND FIRE



Glaciers and volcanoes have played major roles in shaping Alaska's landscape. About 100,000 glaciers still exist in Alaska, covering about 29,000 square miles or 5 percent of the state. Active volcanoes number more than 80.

Superlatives. Alaska's 365 million acres encompass about 34,000 miles of marine coastline, more than 3 million lakes, 39 mountain ranges (including North America's tallest mountain at 20,320 feet), places with more than 200 inches of precipitation annually, and places receiving as little as 5 to 7 inches of total precipitation.

Extremes. Alaska spans the latitudes of 51°13' to 71°23' north. The state experiences temperatures ranging from the 30s to 90s during the summer to the 50s to minus 70s during the winter. Daily sunlight varies from several months of total darkness to several months of total daylight above the Arctic Circle.

Permafrost Enhances Precipitation. Areas of **permafrost** (*perennially frozen ground*) which underlie a majority of Alaska keep water on or near the surface. Water seems abundant because snowmelt and rain cannot drain away. Because of that, even though **precipitation** in Arctic and Interior Alaska is similar to that of deserts, it is enough to support plant growth.

Rainy Coast. By contrast, Southeast and Southcentral Alaska's coastal lands are awash in rainfall. There is no permafrost. The rain makes the area prone to erosion if vegetation is stripped from the steep slopes.

ALASKA'S SNOWY BLANKET

Precipitation in Alaska comes from snow as well as rain. Snow affects the ecosystem in several ways.

1. *Extends Darkness.* Deep snow cover significantly reduces the amount of sunlight reaching buried plants, extending the period of darkness and reducing the time available for photosynthesis. (*See adaptation fact sheets in Alaska's Tundra & Wildlife*, INSIGHTS *Section* 3.)

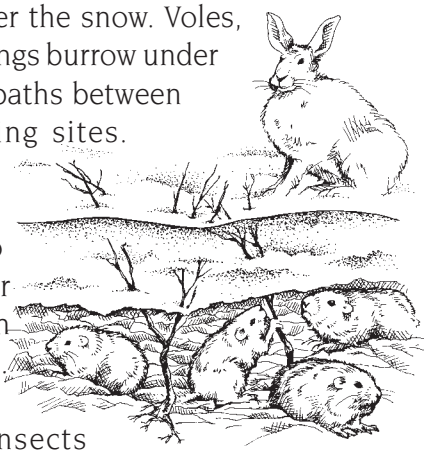
2. *Protects or Scours.* In many wind-blown areas, snow helps to shape vegetation patterns. Under its protective drifts, more plants can survive and thrive. On exposed ridges, wind-blown snow acts as an abrasive to scour away all but the most hardiest or smallest plants.

3. *Retains Earth's Heat.* Snow has great insulating qualities that help life survive in severe environments. Snow is a good **insulator** because air is trapped in between **snow crystals**. The trapped air, a poor **conductor** of **heat energy**, insulates the ground from winter temperatures.

When snow falls in autumn it covers soil that has stored heat energy over the summer. Without additional input of radiant energy from the sun, the ground cools gradually, but **uncompacted** snow acts as an insulating blanket and traps some of the heat given up by the ground. As a result, the ground stays

warmer than winter air, remaining close to 32°F (0°C) – as long as there is a sufficient covering of snow. The ground cools, or gives up heat energy relatively slowly as winter progresses.

Life Under Snow. Some animals are **subnivean** and remain active under the snow. Voles, shrews, and lemmings burrow under the snow and dig paths between feeding and resting sites. Ptarmigan and grouse fold their wings and dive into loose snow for protection from cold and predators.



Some dormant insects rely on the insulating properties of snow to protect them from cold and wind. Insect eggs, cocoons and adults find shelter under vegetation and in the soil.

TOPOGRAPHY & ECOSYSTEMS

Sea Level to Mt. McKinley. Since Alaska rises from sea level to the highest mountain on the continent, the topography of the land plays an important role in shaping the pattern of our weather and our ecosystems. Mountain ranges block rain systems, make their own weather and winds, or concentrate rainfall.

Drainage or Pooling? Steep slopes drain moisture quickly and hamper soil development, limiting what can grow there. Low-lying areas or flats may be underlain by permafrost, creating boggy soils that limit plant growth by drowning their roots. Plant growth on dry sites are different from those on wet sites.

Look for a Sunny Slope. The **aspect** or compass direction of a slope determines exposure to sunshine or wind, how soon the soil warms in spring, and if snow will be scoured away or lay as a protective blanket. Plant communities on north-facing slopes have different members from those on south-facing slopes.

SOIL & ECOSYSTEMS

Alaska's Young Soils. Recent glaciation over much of Alaska left behind coarsely crushed rock and fine rock flour devoid of organic material. These **young soils** lack variety and depth.

Other Plants Prepare a Base. Plants need a foundation for their **roots.** Trees especially depend on many years of other plant growth and accumulation of plant debris to form the **organic soils** that will support their growth.

Permafrost's Chilling Effect. Permafrost is most common in areas with a mean annual soil temperature below 27°F (-3°C). Locally, on south facing slopes or in areas of good drainage, no permafrost may exist.

Roots Need to Breathe. Soil depth and standing water affect a plant's ability to "breathe." Cells in leaves and the branches absorb **oxygen** from the air, but the cells in the roots must absorb oxygen from the soil. Trees literally drown if their roots become waterlogged. Even in arid environments like the Interior, trees and other plants can become waterlogged because permafrost does not permit water to drain away from their roots.

Cold Creates Treeless Muskeg Soils. Cold temperatures slow the growth and decay of plant materials and that slows the development of organic soils. If dead plants accumulate faster than they can be decomposed, an acidic basin called a **muskeg** forms. Muskeg soils, often found within boreal forests, are notoriously poor environments for most tree and plant growth.

Bacteria Make Nutritious Soil. Plants must also have **nitrogen** in order to grow. Most of the nitrogen on earth is in the air, but plants are only able to use nitrogen that is in the soil. Without the soil's nitrogen provided by microscopic bacteria called "nitrogen-fixers," plants could not survive.

LIVING THINGS – 5 KINGDOMS

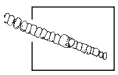
To the various nonliving environments we now add a cast of living things. Living things can move in response to their surroundings they grow and they reproduce. The presence or absence of certain nonliving things dictates which living creatures will survive in a certain area.

Stars are Easier to Count. It is said that scientists have a better understanding of how many stars are in our galaxy than how many species are on Earth. Estimates range from two million to 100 million. New species are still being discovered.

Hey, You! Only 1.4 million species have been named. Only a small fraction of the insects, fish, and non-animal species have been scientifically described and catalogued.

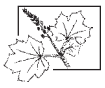
Naming Things. The Swedish naturalist, Carolus Linnaeus, was the first person to devise a method of naming living things. Linnaeus used two categories or **kingdoms** to classify all living things: **Plants** and **Animals**. His system has been modified many times, evolving along with the expanding knowledge of biologists.

More Kingdoms. While scientists are still debating about how to classify some organisms, they now agree on the following five classifications of living things:


monerans (one-celled organisms such as blue-green algae and bacteria)


protists (one-celled organisms including algae and protozoans)


fungi (such as mushrooms and lichens)


plants


animals

The following fact sheets explain the characteristics of each kingdom and highlight some of its members found in Alaska.